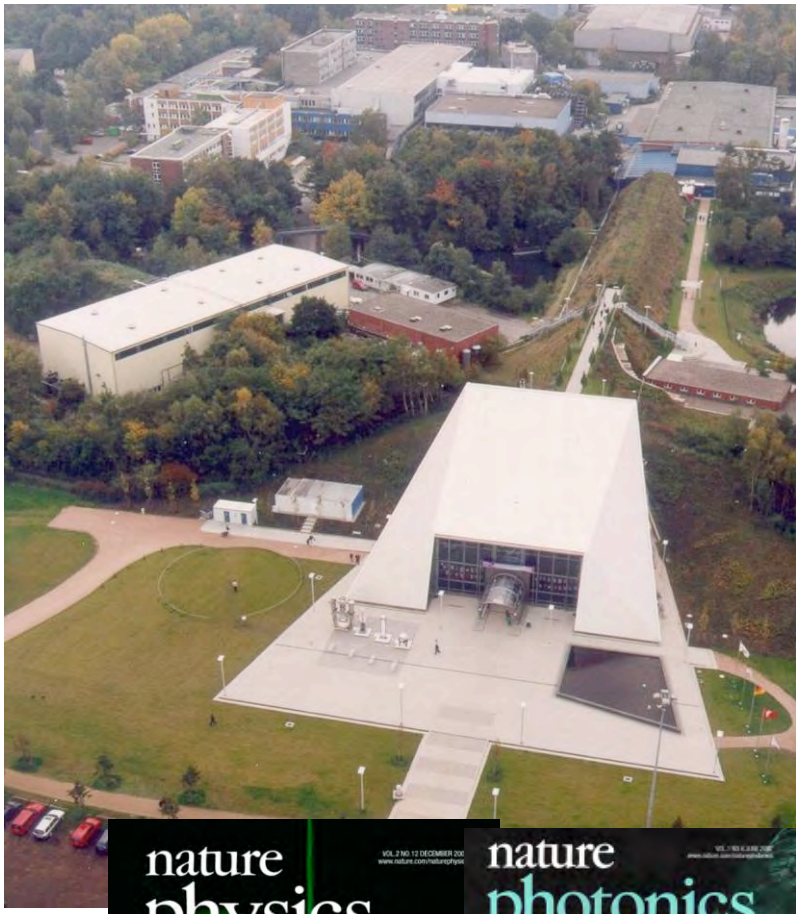
3.9 GHz SRF Cavity Module Update

H Edwards 12/5/2010

- Collaboration with DESY, 3.9 module at DESY<-> 1.3 module at NML
- Learning experience on all steps of SRF cavity design, fabrication, test, assemble, install
- 4 cavity module installed & operating well at DESY FLASH (SASE FEL)
- 3rd harmonic of 1.3 GHz provides correction/linearization of the e bunch E vs t for better, more controlled and efficient bunch compression to sub ps lengths

FLASH aka Tesla Test Facility (TTF)
Dream of Wiik's for linear collider R&D

- Single-pass high-gain SASE FEL
  - **SASE = self-amplified spontaneous emission**
- Photon wavelength range from vacuum ultraviolet to soft x-rays
- Free-electron laser user facility since summer 2005
  - 1st period: Jun 2005 – Mar 2007
  - 2nd period: Nov 2007 – Aug 2009
  - 3rd period: Sep 2010 – Sep 2011
- FLASH is also a test bench for the European XFEL and the International Linear Collider (ILC)
- FLASH II, a second undulator beam line is in preparation

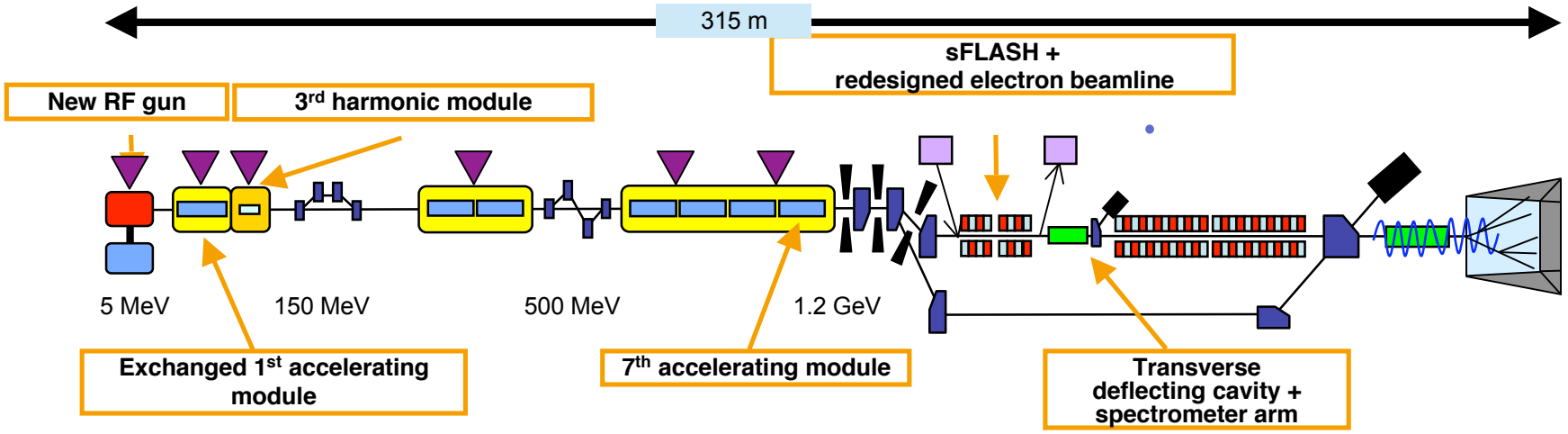


- more than 100 publications on photon science at FLASH in "high impact" journals
  - http://hasylab.desy.de/facilities/flash/publications/selected_publications

The 3.9 GHz bare cavity
Design gradient 14MV/m

The recent FLASH upgrade

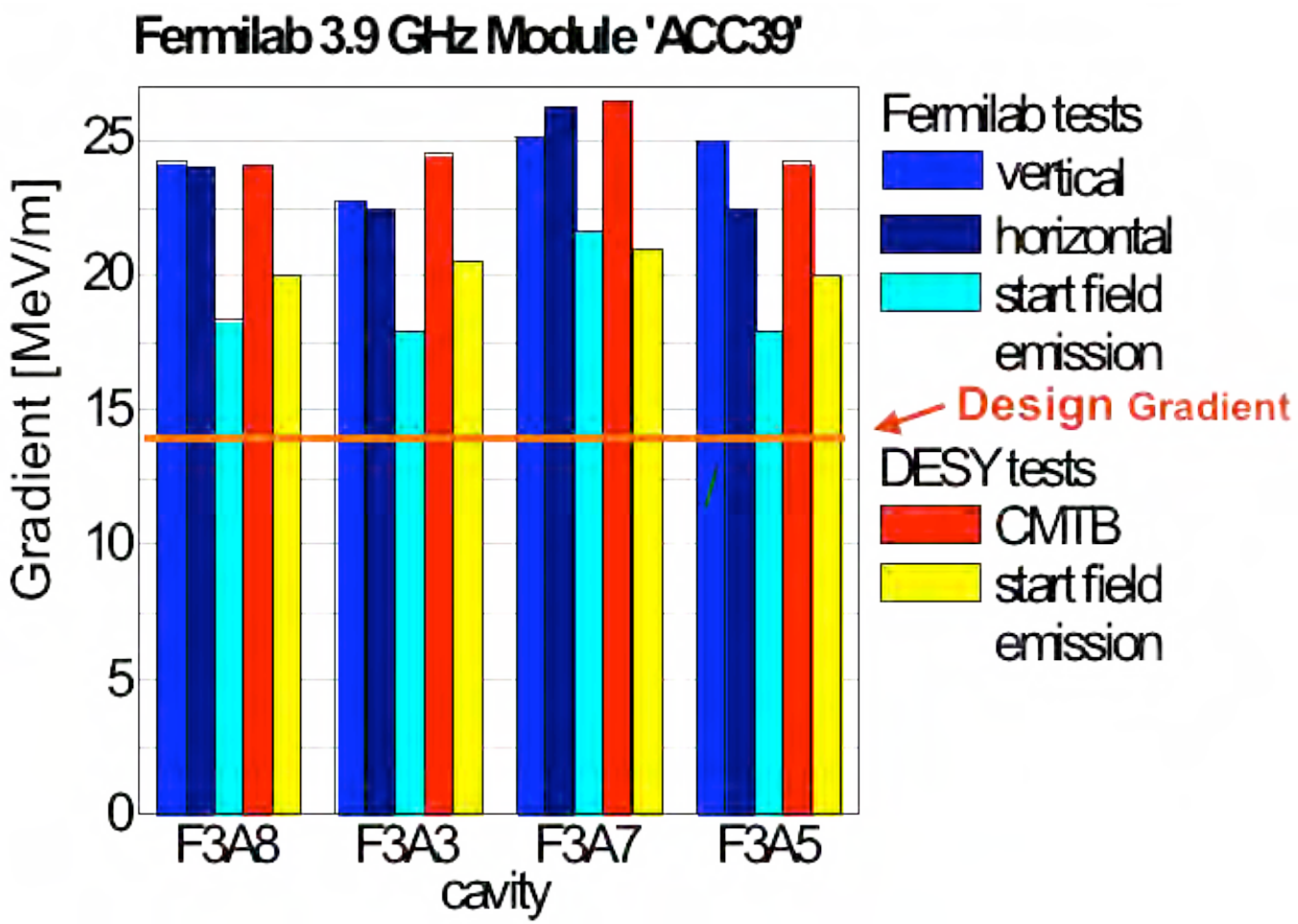
- New injector gun with lower dark current
- 2 new 1.3 GHz modules, ACC1 rebuilt, ACC7 XFEL prototype, 1.2GeV energy
- **The 3.9 GHz module**
- New transverse deflecting cavity diagnostic system using LOLA, in new location
- The sFlash experiment for high harmonic generation (HHG) laser seeding and a new undulator section



Cavity gradient test history
FNAL vertical test to DESY module test

Comparable and consistent results

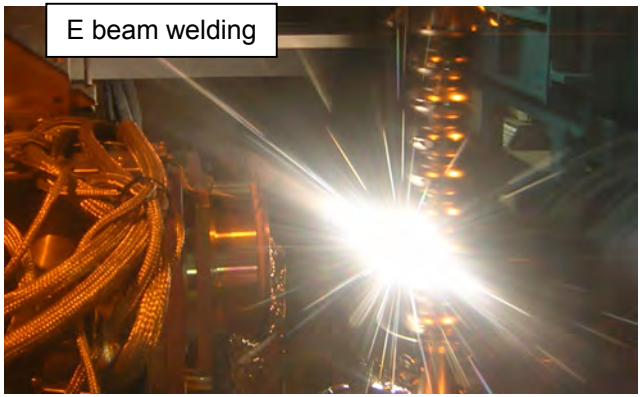
Above design goal



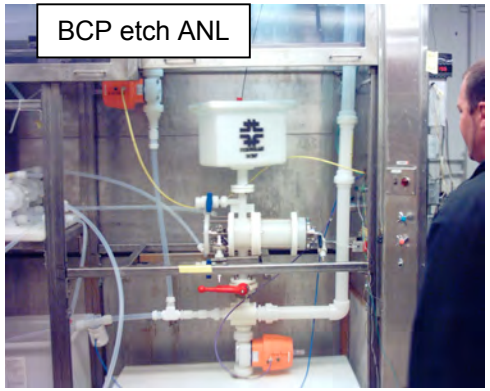
Fabrication, Test & Assembly steps

a learning experience

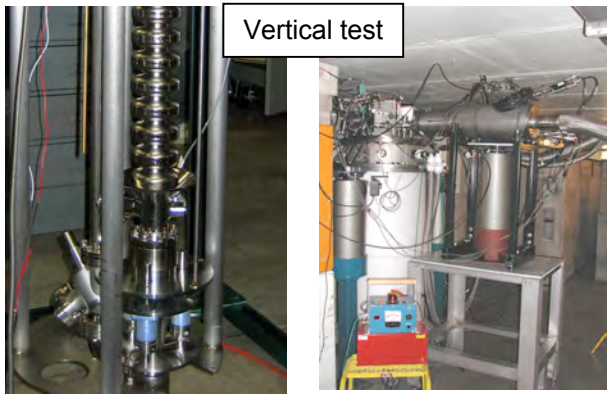
E beam welding



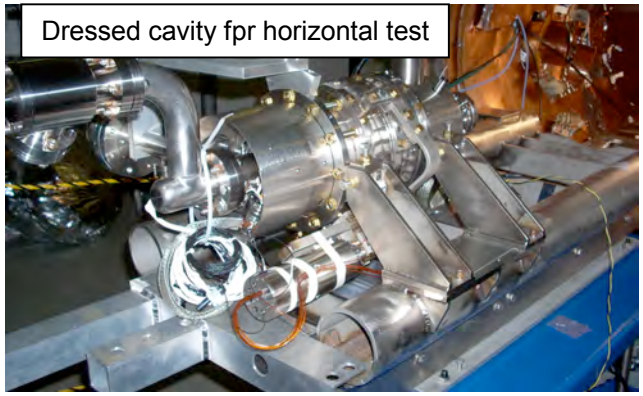
BCP etch ANL



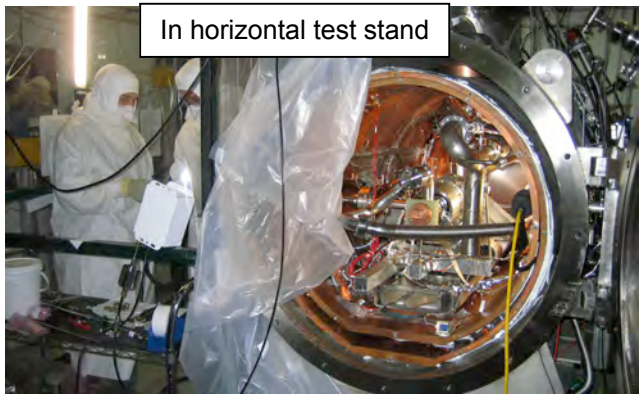
Vertical test



Dressed cavity fpr horizontal test

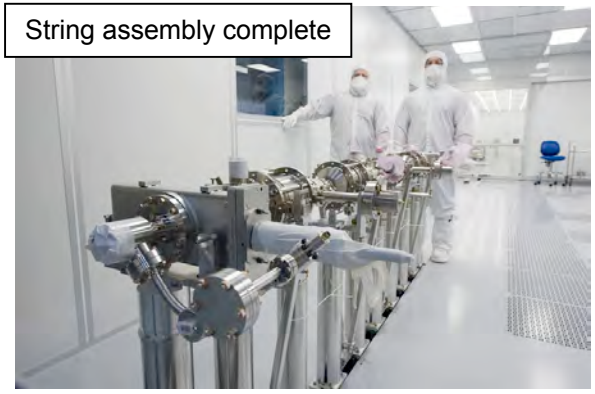


In horizontal test stand



String assembly consultation with DESY

String assembly complete



DESY inspecting string

Preparing for mounting to cold mass

a learning experience, continues

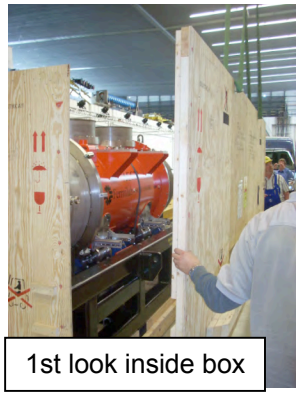

Mounting to the cold mass

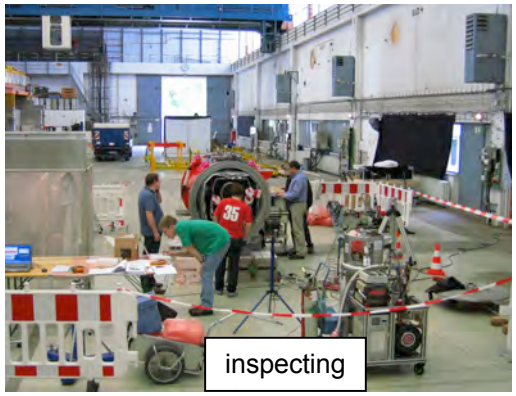

Mounting into vacuum vessel


On shipping frame

To Paris

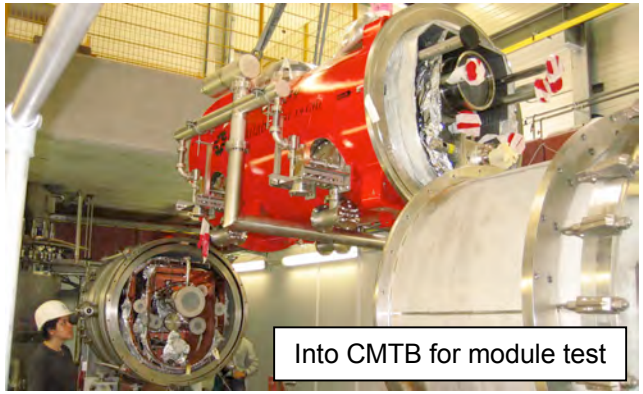
To DESY


1st look inside box


inspecting


Redoing longitudinal string location

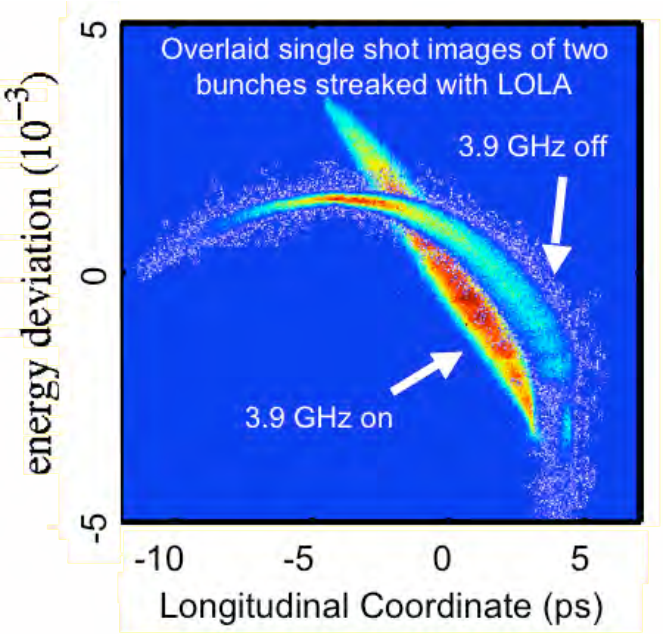

Instrumentation wiring


Into CMTB for module test

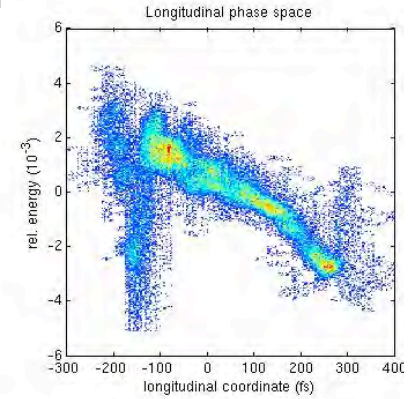
Longitudinal Bunch Shape Measurements

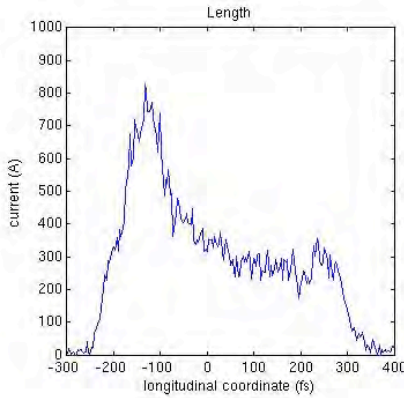
- Bunch shape for slight compression with first accelerating module (ACC1)
  - measured with LOLA deflecting cavity dispersive section at 700 MeV

3.9 cavities Off/On

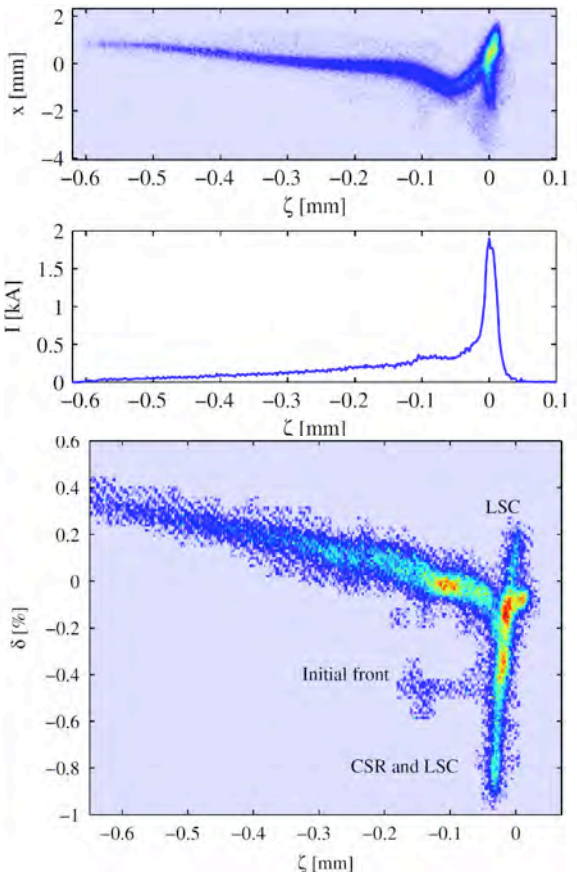


With 3.9 first results
Low charge, low compression





- Without 3.9 linearization
- Longitudinal non-linearity leads to a roll-over compression
  → development of a sharp spike ~ 50 fs fwhh with high peak current
  Measurement & reconstruction
  - (0.3mm=1ps)



Summary

- 39 module operational, excellent learning experience, SRF
- Qualitatively SASE operation improved, Studies in Jan
- Future at XFEL, applications for HEP
- Example of advances in accelerator beam dynamics; manipulation in 6D phase space (A0 activities)


Fermi Team


Installed in FLASH